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(54) Abstract Title
Power saving in audio-visual switching apparatus

(57) A switching apparatus interconnecting three audio-visual devices has three switches SW2, SW4, SW1 with SW3, three power supplies 12, 14, 11 with 13, and a control circuit that controls the power supplies and switches. The first switch, powered by the first power supply, supplies a video signal from the first device (e.g., a television set) or the second device (e.g., a video tape recorder) to the third device (e.g., a decoder). The second switch, powered by the second power supply, supplies an audio signal from the first or second device to the third device. The third switch, powered by the third power supply, supplies audio and video signals from the second or third device to the first device. The control circuit saves power by switching the first, second, and third power supplies off individually when the outputs of the corresponding switches are not required.

FIG.1

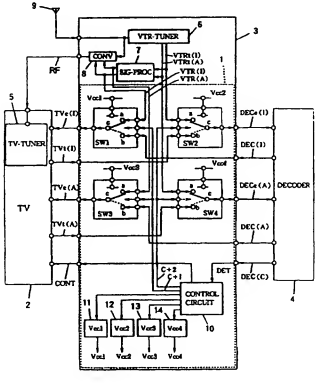

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FIG.1

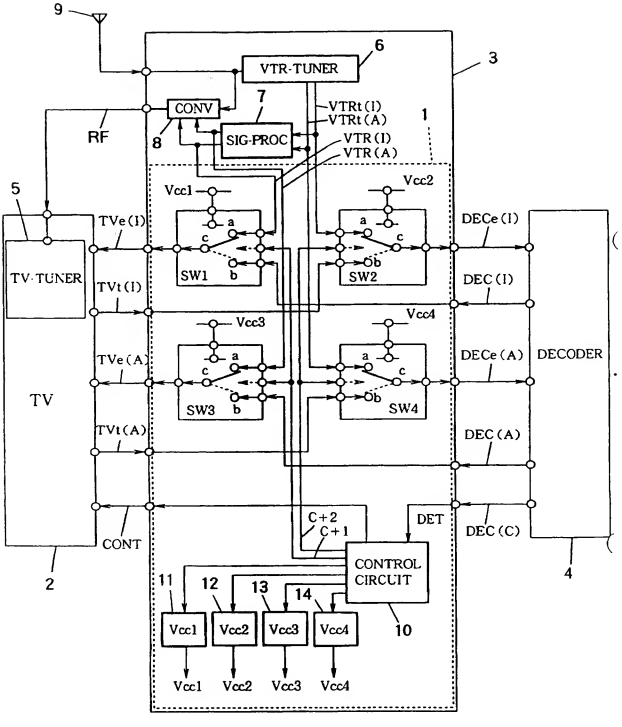

FIG.2

	DEC (C)	Vcc 1	Vcc 2	Vcc 3	Vcc 4	SW 1	SW 2	SW 3	SW 4	TO DECODER		TO TV	
										DECe (I)	DECe (A)	TVe (I)	TVe (A)
VTR ON	L	ON	ON	ON	ON	a	b	a	b	TVt (I)	TVt (A)	VTR (I)	VTR (A)
	H	ON	ON	ON	ON	b	b	b	b	TVt (I)	TVt (A)	DEC (I)	DEC (A)
VTR OFF	L	OFF	ON	OFF	OFF	OFF	b	OFF	OFF	TVt (I)	NO SIGNAL	NO SIGNAL	NO SIGNAL
	H	ON	ON	ON	ON	b	b	b	b	TVt (I)	TVt (A)	DEC (I)	DEC (A)

FIG.3

	DEC (C)	Vcc 1	Vcc 2	Vcc 3	Vcc 4	SW 1	SW 2	SW 3	SW 4	TO DECODER		TO TV	
										DECc (I)	DECe (A)	TVe (I)	TVe (A)
VTR ON	L	ON	ON	ON	ON	a	b	a	b	TVt (I)	TVt (A)	VTR (I)	VTR (A)
	H	ON	ON	ON	ON	b	b	b	b	TVt (I)	TVt (A)	DEC (I)	DEC (A)
VTR OFF	L	OFF	OFF	OFF	ON	OFF	OFF	OFF	b	NO SIGNAL	TVt (A)	NO SIGNAL	NO SIGNAL
	H	ON	ON	ON	ON	b	b	b	b	TVt (I)	TVt (A)	DEC (I)	DEC (A)

FIG.4

	DEC (C)	Vcc 1	Vcc 2	Vcc 3	Vcc 4	SW 1	SW 2	SW 3	SW 4	TO DECODER		TO TV	
										DECc(I)	DECe(A)	TVe(I)	TVe(A)
VTR ON	L	ON	ON	ON	ON	a	b	a	b	TVt(I)	TVt(A)	VTR(I)	VTR(A)
	H	ON	ON	ON	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)
VTR OFF	L	OFF	ON	OFF	ON	OFF	b	OFF	b	TVt(I)	TVt(A)	NO SIGNAL	NO SIGNAL
	H	ON	ON	ON	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)

FIG.5

	DEC (C)	Vcc 1	Vcc 2	Vcc 3	Vcc 4	SW 1	SW 2	SW 3	SW 4	TO DECODER		TO TV	
										DECe(I)	DECe(A)	TVe(I)	TVe(A)
VTR ON	L	ON	ON	ON	OFF	a	b	a	OFF	TVt(I)	NO SIGNAL	VTR(I)	VTR(A)
	H	ON	ON	ON	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)
VTR OFF	L	OFF	ON	OFF	OFF	OFF	b	OFF	OFF	TVt(I)	NO SIGNAL	NO SIGNAL	NO SIGNAL
	H	ON	ON	ON	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)

FIG.6

	DEC (C)	Vcc 1	Vcc 2	Vcc 3	Vcc 4	SW 1	SW 2	SW 3	SW 4	TO DECODER		TO TV	
										DECc (I)	DECe (A)	TVe (I)	TVe (A)
VTR ON	L	ON	OFF	ON	ON	a	OFF	a	b	NO SIGNAL	TVt (A)	VTR (I)	VTR (A)
	H	ON	ON	ON	ON	b	b	b	b	TVt (I)	TVt (A)	DEC (I)	DEC (A)
VTR OFF	L	OFF	OFF	OFF	ON	OFF	OFF	OFF	b	NO SIGNAL	TVt (A)	NO SIGNAL	NO SIGNAL
	H	ON	ON	ON	ON	b	b	b	b	TVt (I)	TVt (A)	DEC (I)	DEC (A)

FIG.7

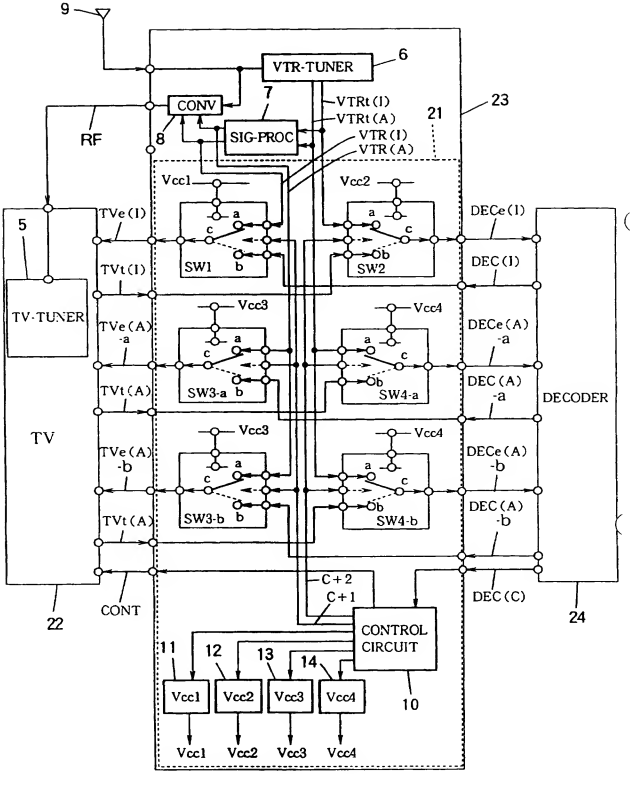

FIG.8

	DEC (C)	Vcc 1	Vcc 2	Vcc 3	Vcc 4	SW 1	SW 2	SW 3-a	SW 3-b	SW 4-a	SW 4-b	TO DECODER			TO TV		
												DECc(I)	DECc(A) -a	DECe(A) -b	TVe(I)	TVe(A) -a	TVe(A) -b
VTR ON	L	ON	ON	ON	ON	a	b	a	a	b	b	TVt(I)	TVt(A)	TVt(A)	VTR(I)	VTR(A)	VTR(A)
	H	ON	ON	ON	ON	b	b	b	b	b	b	TVt(I)	TVt(A)	TVt(A)	DEC(I)	DEC(A) -a	DEC(A) -b
VTR OFF	L	OFF	ON	OFF	OFF	OFF	b	OFF	OFF	OFF	OFF	TVt(I)	NO SIGNAL	NO SIGNAL	NO SIGNAL	NO SIGNAL	NO SIGNAL
	H	ON	ON	ON	ON	b	b	b	b	b	b	TVt(I)	TVt(A)	TVt(A)	DEC(I)	DEC(A) -a	DEC(A) -b

FIG.9

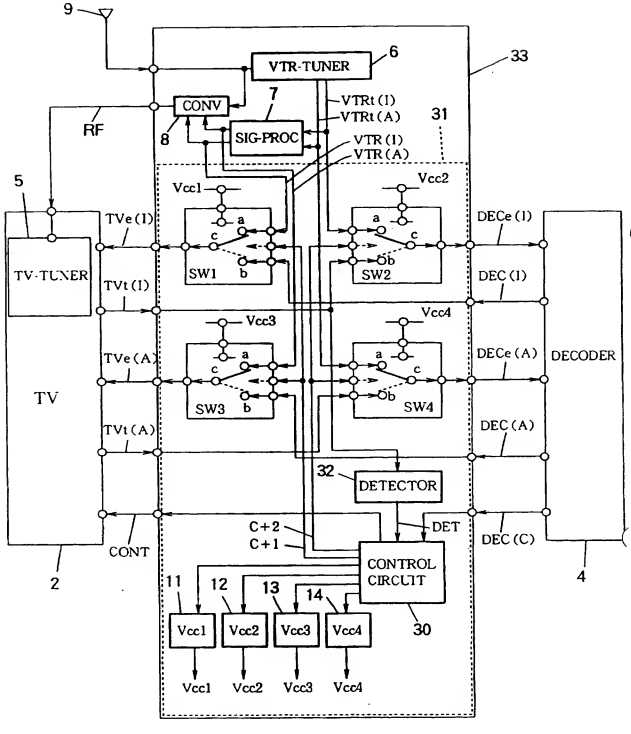

FIG.10

	DEC (C)	DET	Vcc 1	Vcc 2	Vcc 3	Vcc 4	SW 1	SW 2	SW 3	SW 4	TO DECODER		TO TV	
											DECe(I)	DECe(A)	TVe(I)	TVe(A)
VTR ON	L		ON	ON	ON	ON	a	b	a	b	TVt(I)	TVt(A)	VTR(I)	VTR(A)
	H		ON	ON	ON	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)
VTR OFF	L	L	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	NO SIGNAL	NO SIGNAL	NO SIGNAL	NO SIGNAL
		H	OFF	ON	OFF	OFF	OFF	b	OFF	OFF	TVt(I)	NO SIGNAL	NO SIGNAL	NO SIGNAL
	H		ON	ON	ON	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)

FIG.11

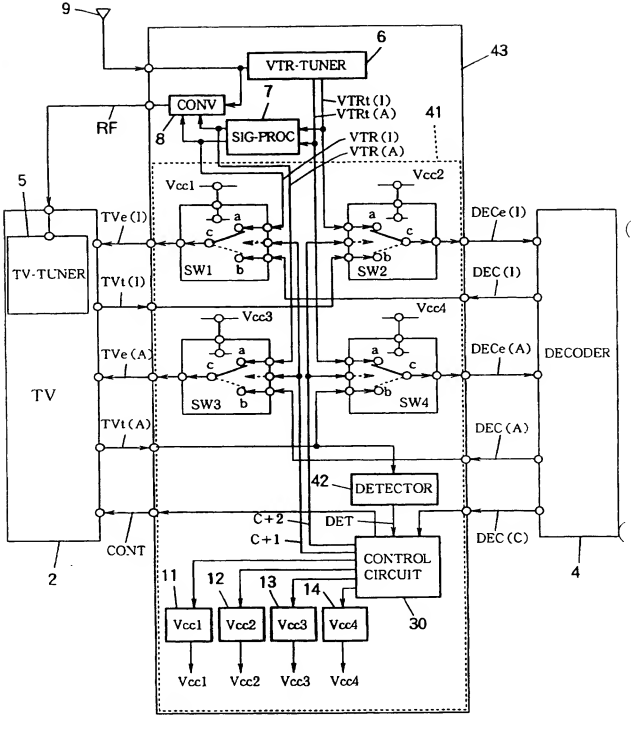

FIG.12

	DEC (C)	DET	Vcc 1	Vcc 2	Vcc 3	Vcc 4	SW 1	SW 2	SW 3	SW 4	TO DECODER		TO TV	
											DECe(I)	DECe(A)	TVe(I)	TVe(A)
VTR ON	L		ON	ON	ON	ON	a	b	a	b	TVt(I)	TVt(A)	VTR(I)	VTR(A)
	H		ON	ON	ON	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)
VTR OFF	L	L	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	NO SIGNAL	NO SIGNAL	NO SIGNAL	NO SIGNAL
		H	OFF	OFF	OFF	ON	OFF	OFF	OFF	b	NO SIGNAL	TVt(A)	NO SIGNAL	NO SIGNAL
	H		ON	ON	ON	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)

FIG.13

PRIOR ART

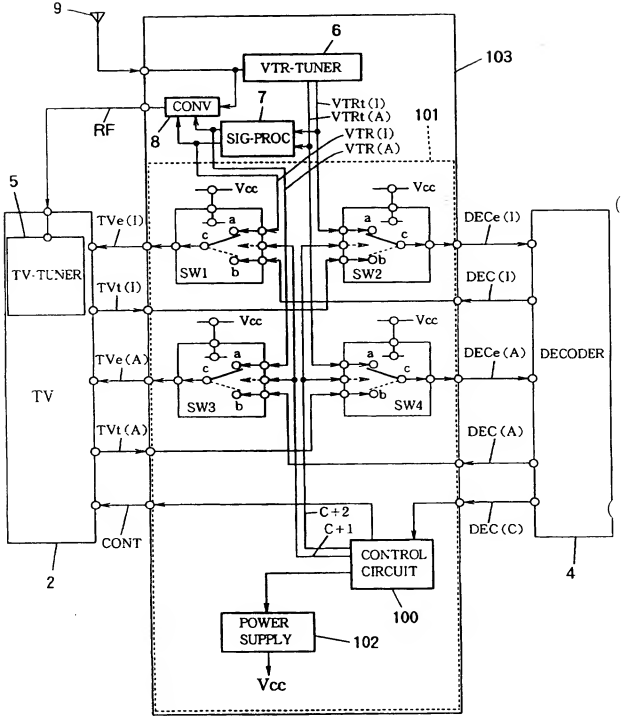

FIG.14

PRIOR ART

	DEC (C)	Vcc 1	SW 1	SW 2	SW 3	SW 4	TO DECODER		TO TV	
							DECe(I)	DECe(A)	TVe(I)	TVe(A)
VTR ON	L	ON	a	b	a	b	TVt(I)	TVt(A)	VTR(I)	VTR(A)
	H	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)
VTR OFF	L	ON	b	b	b	b	TVt(I)	TVt(A)	NO SIGNAL	NO SIGNAL
	H	ON	b	b	b	b	TVt(I)	TVt(A)	DEC(I)	DEC(A)

AUDIO AND VIDEO SWITCHING APPARATUS AND METHOD WITH REDUCED POWER DISSIPATION

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus and method for switching audio and video signals among different audio-visual devices.

In an audio-visual system comprising, for example, a television set, a video tape recorder (VTR), and a decoder for decoding scrambled audio and video signals, the television set and decoder are often interconnected through switches in the VTR. One pair of switches supplies the decoder with signals received by either a tuner in the television set, or a tuner in the VTR. Another pair of switches supplies the television set with signals generated either by the decoder, or by the VTR itself. These switches must operate at all times, so that the television set and decoder can cooperate to receive scrambled broadcasts even when the VTR is switched off. To provide the power necessary to operate the switches, the VTR has a separate power supply that remains on when the VTR's main power supply is switched off. An example of this type of system will be shown later.

A problem is that the separate power supply wastes power by operating even when the VTR is switched off and the television set is not tuned to a scrambled channel; even, for that matter, when the television set and VTR are both switched off.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to prevent unnecessary power dissipation by apparatus for switching audio and video signals among different audio-visual devices.

The invented switching apparatus interconnects a first

audio-visual device generating a first video signal and a first audio signal, a second audio-visual device generating a second video signal and a second audio signal, and a third audio-visual device generating a third video signal and a third audio signal. The switching apparatus has a first switch selectively supplying the first video signal or the second video signal to the third audio-visual device, a second switch selectively supplying the first audio signal or the second audio signal to the third audio-visual device, and a third switch selectively supplying the third audio and video signals, or the second audio and video signals, to the first audio-visual device. The switching apparatus also comprises:

a first power supply supplying power to the first switch;

a second power supply supplying power to the second switch;

a third power supply supplying power to the third switch; and

a control circuit controlling the first, second, and third switches, and turning the first power supply, the second power supply, and the third power supply individually on and off.

The control circuit conserves power by turning the first, second, and third power supplies off individually when they are not needed.

In the invented method of controlling a switching apparatus having switches as described above, the third audio-visual device detects scrambling, decodes the video and audio signals received from the first and second switches if they are scrambled, provides decoded video and audio signals to the third switch, and generates an information signal indicating the presence or absence of scrambling. The method comprises the steps of:

supplying power to the first, second, and third switches when the second audio-visual device is switched off and the information signal indicates the presence of scrambling; and

denying power to the third switch when the second audio-visual device is switched off and the information signal indicates the absence of scrambling.

Power may also be denied to the first switch or the second switch, or both, under predetermined conditions.

BRIEF DESCRIPTION OF THE DRAWINGS

In the attached drawings:

FIG. 1 is a schematic diagram illustrating the first five embodiments of the invention;

FIG. 2 is a table illustrating the operation of the first embodiment;

FIG. 3 is a table illustrating the operation of the second embodiment;

FIG. 4 is a table illustrating the operation of the third embodiment;

FIG. 5 is a table illustrating the operation of the fourth embodiment;

FIG. 6 is a table illustrating the operation of the fifth embodiment;

FIG. 7 is a schematic diagram illustrating a sixth embodiment of the invention;

FIG. 8 is a table illustrating the operation of the sixth embodiment;

FIG. 9 is a schematic diagram illustrating a seventh embodiment of the invention;

FIG. 10 is a table illustrating the operation of the seventh embodiment;

FIG. 11 is a schematic diagram illustrating an eighth embodiment of the invention;

FIG. 12 is a table illustrating the operation of the eighth embodiment;

FIG. 13 is a schematic diagram illustrating an audio-visual system with a conventional switching apparatus; and

FIG. 14 is a table illustrating the operation of the conventional switching apparatus.

DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the invention will be described with reference to the attached drawings, in which like parts are indicated by like reference characters.

Referring to FIG. 1, the first embodiment is a switching apparatus 1 that switches audio and video signals in a system comprising a television set (TV) 2, a VTR 3 such as a video cassette recorder, and a decoder 4. The switching apparatus 1 is disposed in the VTR 3.

The invention can also be practiced when the switching apparatus 1 is disposed in the television set 2 or decoder 4, or is an independent unit, although these cases will not be illustrated.

The television set 2 has an input terminal for receiving a radio-frequency television signal RF, a TV tuner 5 that selects a frequency channel in the received television signal RF and generates a video signal TVt(I) and an audio signal TVt(A), and output terminals from which TVt(I) and TVt(A) are supplied to the switching apparatus 1. The television set 2 also has input terminals for receiving a control signal CONT, a video signal TVe(I), and an audio signal TVe(A) from the switching apparatus 1. In addition, the television set 2 has a picture tube and a loudspeaker (not visible) with which a picture and sound are reproduced from the signals TVt(I) and TVt(A) when the control signal CONT is at the low logic level, and from the signals TVe(I) and TVe(A) when the control signal CONT is at the high logic

level. The television set 2 may be capable of reproducing both video signals TVt(I) and TVe(I) simultaneously, by generating a picture-in-picture display, for example, in response to a further control signal (not shown).

The decoder 4 has input terminals for receiving a video signal DECe(I) and an audio signal DECe(A) from the switching apparatus 1, and output terminals for supplying a video signal DEC(I), an audio signal DEC(A), and an information signal DEC(C) to the switching apparatus 1. The input signals DECe(I) and DECe(A) may be ordinary video and audio signals, or they may have been scrambled by a broadcaster who charges a fee for the use of the decoder 4. Circuits (not visible) in the decoder 4 recognize whether the input signals are scrambled, decode the input signals if they are scrambled, supply the decoded signals to the switching apparatus 1 as DEC(I) and DEC(A), set the information signal DEC(C) to the high logic level when the input signals are scrambled, and set DEC(C) to the low logic level when the input signals are not scrambled. DEC(C) is also set to the low logic level when no input signals are supplied to the decoder 4.

The VTR 3 has a VTR tuner 6, a signal-processing (SIG-PROC) circuit 7, a radio-frequency signal converter (CONV) 8, an input terminal for receiving a television broadcast signal from an external antenna 9, and an output terminal from which the radio-frequency television signal RF is supplied to the television set 2. The VTR 3 also comprises the switching apparatus 1, and various well-known mechanical and electronic components, including magnetic heads and a servo mechanism (not visible), for recording and reproducing video and audio signals on magnetic tape. In addition, the VTR 3 has a main power supply (not visible) by which the TV tuner 5, the signal-processing circuit 7, the radio-frequency signal converter 8, and the above-mentioned

mechanical and electronic components are powered.

When the main power supply of the VTR 3 is switched on, the VTR tuner 6 generates a video signal VTRt(I) and an audio signal VTRt(A) from the broadcast signal received at the antenna 9. These signals VTRt(I) and VTRt(A) are supplied to the switching apparatus 1 and signal-processing circuit 7. The signal-processing circuit 7 supplies an additional video signal VTR(I) and audio signal VTR(A) to the switching apparatus 1 and the radio-frequency signal converter 8. When the VTR 3 operates in its reproducing mode, VTR(I) and VTR(A) are obtained by processing signals from the magnetic heads. When the VTR 3 is not operating in its reproducing mode, VTR(I) is the same as VTRt(I), and VTR(A) is the same as VTRt(A). When the VTR 3 operates in its recording mode, the signal-processing circuit 7 also supplies VTRt(I) and VTRt(A) to the magnetic heads, with additional processing, such as luminance-chrominance separation, as necessary. The radio-frequency signal converter 8 modulates VTR(I) and VTR(A) onto a carrier signal with a predetermined frequency, adds the modulated carrier signal to the radio-frequency broadcast signal received from the antenna 9, and supplies the resulting signal to the VTR tuner 6 as the radio-frequency television signal RF.

The switching apparatus 1 comprises a control circuit 10, four power supplies 11, 12, 13, 14, four switches SW1, SW2, SW3, SW4, input terminals for receiving signals TVt(I) and TVt(A) from the television set 2 and signals DEC(I), DEC(A), and DEC(C) from the decoder 4, and output terminals for supplying signals TVe(I), TVe(A), and CONT to the television set 2 and signals DECe(I) and DECe(A) to the decoder 4.

Each of the four switches SW1, SW2, SW3, SW4 has two input terminals (a, b), one output terminal (c), and a

control terminal. When supplied with power, each switch operates in one of two states, as selected by a control signal received from the control circuit 10 at the control terminal. In one state, referred to below as state a, the output terminal c is connected to input terminal a. In the other state, referred to below as state b, the output terminal c is connected to input terminal b. Switches SW1 and SW3 are both controlled by the same control signal C+1. Switches SW2 and SW4 are both controlled by the same control signal C+2. When a switch is not supplied with power, its output terminal c is disconnected from both input terminals a and b, leaving the switch in an open state.

Switch SW1 receives power Vcc1 from power supply 11, receives video signal VTR(I) at input terminal a, receives video signal DEC(I) at input terminal b, and supplies video signal TVe(I) from output terminal c to the television set 2. Switch SW3 receives power Vcc3 from power supply 13, receives audio signal VTR(A) at input terminal a, receives audio signal DEC(A) at input terminal b, and supplies audio signal TVe(A) from output terminal c to the television set 2.

Switch SW2 receives power Vcc2 from power supply 12, receives video signal VTRt(I) at input terminal a, receives video signal TVt(I) at input terminal b, and supplies video signal DECe(I) from output terminal c to the decoder 4. Switch SW4 receives power Vcc4 from power supply 14, receives audio signal VTRt(A) at input terminal a, receives audio signal TVt(A) at input terminal b, and supplies audio signal DECe(A) from output terminal c to the decoder 4.

Switches SW1, SW2, SW3, and SW4 are preferably solid-state switches comprising, for example, discrete bipolar transistors, bipolar integrated circuits, or complementary metal-oxide-semiconductor (CMOS) integrated circuits. All four switches may reside in the same integrated circuit package, if the package has a separate power supply lead for

each switch. CMOS integrated circuits have the advantage of low power consumption, but the invention is not limited to any particular type of switch.

Power supplies 11, 12, 13, 14 (also denoted Vcc1, Vcc2, Vcc3, Vcc4) are individually controlled by the control circuit 10, and operate independently of the main power supply of the VTR 3. The control circuit 10 can switch Vcc1, Vcc2, Vcc3, Vcc4, and the main power supply of the VTR 3 on and off individually. The control circuit 10 controls power supplies 11, 12, 13, 14 according to the information signal DEC(C), and to internal information indicating the on-off status of the main power supply of the VTR 3. The control circuit 10 has an independent power supply (not visible) and continues to operate when the main power supply of the VTR 3 is switched off.

The control circuit 10 generates control signal C+1 from the information signal DEC(C). When DEC(C) is low, indicating that the signals received by the decoder 4 are not scrambled, control signal C+1 sets switches SW1 and SW3 to state a, so that the television set 2 receives signals VTR(I) and VTR(A) from the VTR 3. When DEC(C) is high, indicating scrambled signals, control signal C+1 sets switches SW1 and SW3 to state b, so that the television set 2 receives decoded signals DEC(I) and DEC(A) from the decoder 4.

The control circuit 10 generates control signal C+2 from internal information, indicating whether the main power supply of the VTR 3 is on or off, and from a tuner setting, not shown in the drawings. The tuner setting, which is valid only when the main power supply of the VTR 3 is switched on, selects the TV tuner 5 or the VTR tuner 6. When the main power supply of the VTR 3 is switched on and the VTR tuner 6 is selected, control signal C+2 sets switches SW2 and SW4 to state a, so that the decoder 4 receives signals VTRt(I) and

VTRt(A) from the VTR 3. When the main power supply of the VTR 3 is switched on and the TV tuner 5 is selected, control signal C+2 sets switches SW2 and SW4 to state b, so that the decoder 4 receives signals TVt(I) and TVt(A) from the television set 2. When the main power supply of the VTR 3 is switched off, the VTR tuner 6 does not operate, so control signal C+2 sets switches SW2 and SW4 to state b.

The control circuit 10 also generates the control signal CONT supplied to the television set 2. In one exemplary control scheme, when the TV tuner 5 is selected, if the information signal DEC(C) is low, indicating non-scrambled signals, control signal CONT is also driven low, instructing the television set 2 to reproduce a picture and sound from the output of the TV tuner 5. If the information signal DEC(C) is high, indicating scrambled signals, the control signal CONT is driven high, instructing the television set 2 to reproduce a picture and sound from the signals supplied from the decoder 4 through the switching apparatus 1. Control signal CONT is also driven high when VTR 3 is switched on and the tuner setting selects the VTR tuner 6.

The control circuit 10 may be a computing device such as a microcontroller, or a logic circuit constructed from an integrated array of gates, or from discrete logic devices.

The operation of the first embodiment will now be described with reference to FIG. 2. In this and subsequent drawings, VTR ON indicates that the main power supply of the VTR 3 is switched on; VTR OFF indicates that the main power supply of the VTR 3 is switched off. The letters H and L indicate whether the information signal DEC(C) is high or low. The columns headed Vcc1 to Vcc4 indicate whether power supplies 11, 12, 13, 14 are on or off. The letters a and b indicate the states of switches SW1 to SW4. The right half of the table indicates which signals are supplied to the

decoder 4 as DECe(I) and DECe(A), and which signals are supplied to the television set 2 as TVe(I) and TVe(A).

It will be assumed throughout the following description that the tuner setting, when valid, selects the TV tuner 5.

When the main power supply of the VTR 3 is switched on, the control circuit 10 switches on all four power supplies 11, 12, 13, 14, supplying power to all four switches SW1, SW2, SW3, SW4. Switches SW2 and SW4 are controlled by control signal C+2 according to the tuner setting, and are set to state b since, by the above assumption, the tuner setting selects the TV tuner 5. The decoder 4 receives video signal TVt(I) from the television set 2 as input signal DECe(I), and audio signal TVt(A) from the television set 2 as input signal DECe(A).

If these signals TVt(I) and TVt(A) are not scrambled, then the information signal DEC(C) output from the decoder 4 is low, and the control circuit 10 uses control signal C+1 to set switches SW1 and SW2 to state a. The television set 2 then receives video signal VTR(I) from the VTR 3 as input signal TVe(I), and audio signal VTR(A) from the VTR 3 as input signal TVe(A).

If the user changes the channel selection of the television set 2 to select a scrambled channel, the decoder 4 begins to receive scrambled input signals DECe(I) and DECe(A), and drives the information signal DEC(C) to the high logic level. The decoder 4 also begins decoding the scrambled signals, and outputs a decoded video signal DEC(I) and a decoded audio signal DEC(A). Since the information signal DEC(C) is high, the control circuit 10 changes control signal C+1 to set switches SW1 and SW3 to state b. The television set 2 now receives decoded video signal DEC(I) from the decoder 4 as input signal TVe(I), and decoded audio signal DEC(A) from the decoder 4 as input signal TVe(A). The control circuit drives control signal

CONT high, and the television set 2 reproduces a picture and sound from the decoded signals.

If the user changes the channel selection again to select a non-scrambled channel, the decoder 4 recognizes that DECe(I) and DECe(A) are not scrambled and returns the information signal DEC(C) to the low logic level. The control circuit 10 then changes control signal C+1 to set switches SW1 and SW3 to state a, and the television set 2 again receives signals VTR(I) and VTR(A) from the VTR 3 as input signals TVe(I) and TVe(A).

When the main power supply of the VTR 3 is switched off, the control circuit 10 activates power supply 12 and uses control signal C+2 to set switch SW2 to state b, so that the decoder 4 receives video signal TVt(I) from the television set 2 as input signal DECe(I). If this signal is not scrambled, the decoder 4 sets the information signal DEC(C) to the low logic level, and the control circuit 10 responds by turning off power supplies 11, 13, 14, thereby denying power Vcc1, Vcc3, Vcc4 to switches SW1, SW3, SW4. These three switches are placed in an inactive (open) state; the decoder 4 receives no audio input signal from the switching apparatus 1, and the television set 2 receives no audio or video signal from the switching apparatus 1.

Similarly, if TVt(I) is absent because the television set 2 is switched off, the information signal DEC(C) goes low, and the control circuit 10 turns off power supplies 11, 13, 14.

If the user changes the channel selection of the television set 2 to select a scrambled channel, the decoder 4 begins to receive a scrambled video signal TVt(I) as input signal DECe(I), and drives the information signal DEC(C) to the high logic level. The control circuit 10 responds by switching on power supplies 11, 13, 14, and leaving power supply 12 on, so that all four switches SW1, SW2, SW3, and

SW4 receive power. Using control signals C+1 and C+2, the control circuit 10 sets all four switches to state b, so that the decoder 4 receives the scrambled audio signal TVt(A) as input signal DECe(A), as well as the scrambled video signal TVt(I) as input signal DECe(I). The decoder 4 decodes both scrambled signals and outputs the decoded signals DEC(I) and DEC(A), which are routed through switches SW1 and SW3 to the television set 2 as input signals TVe(I) and TVe(A). The control circuit 10 also drives control signal CONT to the high logic level, and the television set 2 reproduces the decoded signals.

If the user changes the channel selection again and returns to a non-scrambled channel, the decoder 4 drives the information signal DEC(C) back to the low level, and the control circuit 10 responds by turning off power supplies 11, 13, 14, thus deactivating switches SW1, SW3, SW4, and driving CONT low. The decoder 4 then receives only the video signal TVt(I) output from the television set 2 as input signal DECe(I). The decoder 4 continues to monitor TVt(I) for further changes from the unscrambled to the scrambled state.

While the user is watching an unscrambled broadcast on the television set 2, the VTR 3 can be switched on to record a separate broadcast on magnetic tape, and switched off when the recording is completed. Throughout this process, power supply 12 remains on, and the decoder 4 continues to output a low information signal DEC(C), indicating the reception of an unscrambled video signal from the television set 2 through switch SW2. When the VTR 3 is switched on, the control circuit 10 activates power supplies 11, 13, 14 and sets switches SW1 and SW3 to state a, causing the television set 2 to receive video and audio signals VTR(I) and VTR(A) from the VTR 3. When the VTR 3 is switched off, the control circuit 10 deactivates power supplies 11, 13, 14, denying

power to switches SW1, SW3, SW4.

Similarly, the VTR 3 can be switched on and off to record while the user is watching a scrambled broadcast. All four power supplies 11, 12, 13, 14 remain active, and all four switches SW1, SW2, SW3, SW4 remain set to position b. The decoder 4 decodes the scrambled audio and video signals TVt(I) and TVt(A) received from the TV tuner 5 through switches SW2 and SW4, and the television set 2 reproduces the decoded signals DEC(I) and DEC(A) received from the decoder 4 through switches SW1 and SW3. Independently of these operations, the VTR 3 records the signals VTRt(I) and VTRt(A) from the VTR tuner 6.

When the VTR 3 reproduces signals recorded on a magnetic tape, the television set 2 receives the reproduced signals through the radio-frequency signal converter 8, as part of the radio-frequency television signal RF. If the user selects a channel corresponding to the predetermined frequency assigned to the VTR 3, the signals reproduced by the VTR 3 are converted to audio and video signals by the TV tuner 5, and passed through switches SW2 and SW4 to the decoder 4. If these signals are not scrambled, the information signal DEC(C) and control signal CONT are both low, and the television set 2 reproduces a picture and sound from the output of the TV tuner 5. If the signals are scrambled, the information signal DEC(C) and control signal CONT go high, all switches are set to position b, the decoder 4 decodes the scrambled signals received from the television set 2 through switches SW2 and SW4, and the television set 2 reproduces the decoded signals received from the decoder 4 through switches SW1 and SW3.

The first embodiment operates in various modes as described above, but in typical usage, much time is spent in the mode in which the user watches an unscrambled broadcast on the television set 2 with the VTR 3 switched off. In this

mode, the first embodiment saves power by switching off power supplies 11, 13, 14, while still allowing switch SW2 to operate on power supply 12, so that the decoder 4 can monitor the video signal and detect possible changes from unscrambled to scrambled content.

Much time is also spent in the non-operating mode in which both the television set 2 and VTR 3 are switched off. The first embodiment also saves power in this mode, by switching off power supplies 11, 13, 14.

The first embodiment is not limited to systems comprising a television set, a video tape recorder, and a decoder. The same type of switching control can be practiced in other system configurations, such as configurations including a video disk device, and in systems receiving a signal from a cable instead of an antenna.

In a variation of the first embodiment, power supplies 11 and 13 are combined into a single unit supplying power to both switches SW1 and SW3, which operate as a single switching unit. The switching apparatus then has a first power supply (Vcc2), a second power supply (Vcc4), a third power supply (combining Vcc1 and Vcc3), a first switch (SW2), a second switch (SW4), and a third switch (combining SW1 and SW3, typically into a single integrated circuit).

In another variation, if two or more of the four power supplies 11, 12, 13, 14 provide the same output voltage, these power supplies are combined into a single power supply with separate output channels that can be switched on and off independently. If all four output voltages are the same, for example, it suffices to have a single power supply with four separately switchable output channels, or with three separately switchable output channels if switches SW1 and SW3 are powered from the same channel. In this case, the "first power supply" is the first output channel of the power supply, the "second power supply" is the second output

channel of the same power supply, and so on.

In yet another variation, switches SW1, SW2, SW3, SW4 operate in a predetermined state (a or b) when not powered, instead of being left open.

Other variations can be obtained by providing the control circuit 10 with additional information, such as time information, for use in determining when to switch the power supplies 11, 12, 13, 14 on and off.

The above variations also apply to the following embodiments.

A second embodiment will now be described. The second embodiment has the same structure as the first embodiment, shown in FIG. 1, but differs in the operation of the control circuit 10. Specifically, when the main power supply of the VTR 3 is switched off and the information signal DEC(C) is low, the control circuit 10 allows the decoder 4 to monitor audio signal TVt(A) instead of video signal TVt(I).

The operation of the second embodiment is summarized in FIG. 3, using the same notation as in FIG. 2. The same operations as in the first embodiment are performed when the main power supply of the VTR 3 is switched on, and when the main power supply of the VTR 3 is switched off if the information signal DEC(C) is high, indicating a scrambled audio signal DECe(A).

When the main power supply of the VTR 3 is switched off and the information signal DEC(C) is low, indicating that the audio signal DECe(A) is not scrambled, the control circuit 10 switches off power supplies 11, 12, 13, leaving only power supply 14 switched on. Switches SW1, SW2, and SW3 become inactive (open), while switch SW4 is set to state b. The decoder 4 receives audio signal TVt(A) as input signal DECe(A), but does not receive a video input signal. The television set 2 receives neither an audio nor a video signal from the switching apparatus 1.

In this state, if the TV tuner 5 begins to output scrambled video and audio signals TVt(I) and TVt(A), the decoder 4 detects the scrambling of the audio input signal DECe(A), and drives the information signal DEC(C) high. The control circuit 10 responds by activating power supplies 11, 12, 13, so that all four power supplies are switched on and all four switches SW1, SW2, SW3, SW4 operate. The control signals C+1 and C+2 set all four switches to state b. The control circuit 10 drives control signal CONT to the high level. The decoder 4 receives scrambled video and audio signals TVt(I) and TVt(A) through switches SW2 and SW4 as input signals DECe(I) and DECe(A). The television set 2 receives decoded video and audio signals DEC(I) and DEC(A) through switches SW1 and SW3 as input signals TVe(I) and TVe(A), and reproduces the decoded signals as a picture and sound.

The second embodiment provides substantially the same effect as the first embodiment, saving power by switching off three of the four power supplies 11, 12, 13, 14 when the main power supply of the VTR 3 is switched off and the signals output by the TV tuner 5 are unscrambled or absent.

Next, a third embodiment will be described. The third embodiment has the same structure as the first and second embodiments, but differs in the operation of the control circuit 10. When the main power supply of the VTR 3 is switched off and the information signal DEC(C) is low, the control circuit 10 allows the decoder 4 to monitor both video signal TVt(I) and audio signal TVt(A).

FIG. 4 summarizes the operation of the third embodiment, using the same notation as in FIG. 2. The same operations as in the first embodiment are performed when the main power supply of the VTR 3 is switched on, and when the main power supply of the VTR 3 is switched off if the information signal DEC(C) is high, indicating scrambled input signals.

When the main power supply of the VTR 3 is switched off and the information signal DEC(C) is low, indicating that the signals DECe(I) and DECe(A) are not scrambled, the control circuit 10 switches off power supplies 11 and 13, but leaves power supplies 12 and 14 switched on. Switches SW1 and SW3 become inactive, while switches SW2 and SW4 are set to state b. The decoder 4 receives video signal TVt(I) as input signal DECe(I), and audio signal TVt(A) as input signal DECe(A). The television set 2 receives neither an audio nor a video signal from the switching apparatus 1.

In this state, if the TV tuner 5 begins to output scrambled signals TVt(I) and TVt(A), the decoder 4 detects the scrambling of the video and audio input signals DECe(I) and DECe(A), and drives the information signal DEC(C) high. The control circuit 10 responds by activating power supplies 11 and 13, so that all four power supplies are switched on and all four switches SW1, SW2, SW3, SW4 operate. The control signals C+1 and C+2 set all four switches to state b. The control circuit 10 drives control signal CONT to the high level. The decoder 4 receives scrambled video and audio signals TVt(I) and TVt(A) through switches SW2 and SW4 as input signals DECe(I) and DECe(A). The television set 2 receives decoded video and audio signals DEC(I) and DEC(A) through switches SW1 and SW3 as input signals TVe(I) and TVe(A), and reproduces the decoded signals as a picture and sound.

The third embodiment saves power by switching off two of the four power supplies 11, 12, 13, 14 when the main power supply of the VTR 3 is switched off and the output of the TV tuner 5 is unscrambled or absent.

In a variation of the third embodiment, power supplies 12 and 14 are combined into a single unit. As noted above, power supplies 11 and 13 can also be combined into a single unit, so the structure of the switching apparatus 1 can be

simplified by using only two power supplies instead of four.

Next, a fourth embodiment will be described. The fourth embodiment has the same structure as the first embodiment, but differs by always switching off power supply 14 when video signal DECe(I) is not scrambled, even if the main power supply of the VTR 3 is on.

FIG. 5 summarizes the operation of the fourth embodiment. The same operations as in the first embodiment are performed when the main power supply of the VTR 3 is switched off, and when the main power supply of the VTR 3 is switched on if the information signal DEC(C) is high.

When the main power supply of the VTR 3 is switched on and the information signal DEC(C) is low, indicating that the video signal DECe(I) is not scrambled, the control circuit 10 activates power supplies 11, 12, 13, and switches power supply 14 off. Switches SW1, SW2, SW3 operate, but switch SW4 does not. As in the first embodiment, the control circuit 10 drives control signal CONT to the low level, and sets control signals C+1 and C+2 so that switches SW1 and SW3 are in state a, while switch SW2 is in state b, because the TV tuner 5 is selected. The television set 2 receives video and audio signals VTR(I) and VTR(A) through switches SW1 and SW3. The decoder 4 receives video signal TVt(I) through switch SW2 as input signal DECe(I).

While the main power supply of the VTR 3 is switched on, if the TV tuner 5 begins to output scrambled signals TVt(I) and TVt(A), the decoder 4 detects a scrambled video input signal DECe(I), and drives the information signal DEC(C) to the high level. The control circuit 10 responds by activating power supply 14, leaving power supplies 11, 12, 13 activated, and changing the state of control signals C+1 and CONT. All four switches SW1, SW2, SW3, SW4 now operate in state b. The decoder 4 receives scrambled signals TVt(I) and TVt(A) through switches SW2 and SW4 as input signals

DECe(I) and DECe(A). The television set 2 receives decoded signals DEC(I) and DEC(A) through switches SW1 and SW3 as input signals TVe(I) and TVe(A), and reproduces a picture and sound from the decoded signals.

The fourth embodiment provides the same effect as the first embodiment when the main power supply of the VTR 3 is switched off and the received signal is not scrambled, saving power by switching off three of the four power supplies 11, 12, 13, 14. In addition, the fourth embodiment saves power when the main power supply of the VTR 3 is switched on and the received signal is not scrambled, by switching off power supply 14.

Next, a fifth embodiment will be described. The fifth embodiment has the same structure as the second embodiment, but differs by always switching off power supply 12 when the audio signal DECe(A) is not scrambled, even if the main power supply of the VTR 3 is on.

FIG. 6 summarizes the operation of the fifth embodiment. The same operations as in the second embodiment are performed when the main power supply of the VTR 3 is switched off, and when the main power supply of the VTR 3 is switched on if the information signal DEC(C) is high.

When the main power supply of the VTR 3 is switched on and the information signal DEC(C) is low, indicating that the audio signal DECe(A) is not scrambled, the control circuit 10 activates power supplies 11, 13, 14 and turns off power supply 12. Switches SW1, SW3, SW4 operate, but switch SW2 does not. As in the second embodiment, the control circuit 10 drives control signal CONT to the low level, and sets control signals C+1 and C+2 so that switches SW1 and SW3 are in state a, while switch SW4 is in state b. The television set 2 receives video and audio signals VTR(I) and VTR(A) through switches SW1 and SW3. Since the TV tuner 5 is selected, the decoder 4 receives audio signal TVt(A) through

switch SW4 as input signal DECe(A).

While the main power supply of the VTR 3 is switched on, if the TV tuner 5 begins to output scrambled signals TVt(I) and TVt(A), the decoder 4 detects a scrambled audio input signal DECe(A), and drives the information signal DEC(C) to the high level. The control circuit 10 responds by activating power supply 12, leaving power supplies 11, 13, 14 activated, and changing the state of control signals C+1 and CONT. All four switches SW1, SW2, SW3, SW4 now operate in state b. The decoder 4 receives scrambled signals TVt(I) and TVt(A) through switches SW2 and SW4 as input signals DECe(I) and DECe(A). The television set 2 receives decoded signals DEC(I) and DEC(A) through switches SW1 and SW3 as input signals TVe(I) and TVe(A), and reproduces a picture and sound from the decoded signals.

The fifth embodiment provides substantially the same effect as the fourth embodiment, saving power by switching off one of the four power supplies 11, 12, 13, 14 when the tuner output signals are unscrambled and the VTR 3 is on, and by switching off three of the four power supplies when the tuner output signals are unscrambled and the VTR 3 is off.

Next, a sixth embodiment will be described. The sixth embodiment is adapted to switch decoded signals with two audio channels, as found in some television broadcasts with high-fidelity sound, for example. To accommodate the two audio channels, the television set, VTR, and decoder in the sixth embodiment have additional input and output terminals.

Referring to FIG. 7, the switching apparatus 21 in the sixth embodiment replaces switch SW3 of the first embodiment with a pair of switches SW3-a and SW3-b, both powered by Vcc3 from power supply 13, and both controlled by control signal C+1. Similarly, switch SW4 of the first embodiment is replaced by a pair of switches SW4-a and SW4-b, both powered

by Vcc4 from power supply 14, and both controlled by control signal C+2. Each of these switches SW3-a, SW3-b, SW4-a, and SW4-b is has the same structure as the replaced switches SW3, SW4, connecting a selected one of two input terminals (a, b) to an output terminal (c). Power supplies 11, 12, 13, 14, switches SW1, SW2, and the control circuit 10 are substantially the same as in the first embodiment.

The television set 22 has two audio output terminals that supply the same audio signal TVt(A) to the b input terminals of switches SW4-a and SW4-b, and two audio input terminals that receive two audio signals TVe(A)-a and TVe(A)-b from switches SW3-a and SW3-b. The audio components (not visible) of the television set 22 are adapted to reproduce both the single-channel audio signal TVt(A) output by the TV tuner 5, and the dual-channel audio signals TVe(A)-a, TVe(A)-b received from the switching apparatus 21. The TV tuner 5 is the same as in the first embodiment.

The VTR 23 has the same VTR tuner 6, signal-processing circuit 7, and radio-frequency signal converter 8 as in the first embodiment. The audio signal VTRt(A) output by the VTR tuner 6 is supplied to the a input terminals of both switches SW4-a and SW4-b. The audio signal VTR(A) output by the signal-processing circuit 7 is supplied to the a input terminals of both switches SW3-a and SW3-b.

The decoder 24 decodes a scrambled audio signal into two decoded audio signals. The decoder 24 has two audio input terminals for receiving identical signals DECe(A)-a and DECe(A)-b from switches SW4-a and SW4-b, and two audio terminals for supplying the decoded audio signals DEC(A)-a and DEC(A)-b to the b input terminals of switches SW3-a and SW3-b. The video input signal DECe(I), video output signal DEC(I), and information signal DEC(C) are the same as in the first embodiment.

FIG. 8 summarizes the operation of the sixth embodiment,

assuming as before that the tuner setting selects the TV tuner 5. Aside from the provision of two audio channels, the sixth embodiment operates in the same way as the first embodiment. Switch SW2 is powered at all times, and the decoder 4 monitors the video input signal DECe(I) to detect the presence of scrambling.

When the video signal DECe(I) is not scrambled, if the main power supply of the VTR 23 is switched off, then power supplies 11, 13, 14 are also switched off to conserve power. Switches SW1, SW3-a, SW3-b, SW4-a, and SW4-b become inactive. The switching apparatus 21 passes video signal TVt(I) from the television set 2 to the decoder 4 as video input signal DECe(I), but does not pass any other audio or video signals.

In other situations, all four power supplies 11, 12, 13, 14 are switched on, and all six switches SW1, SW2, SW3-a, SW3-b, SW4-a, SW4-b operate according to control signals C+1 and C+2.

The sixth embodiment provides substantially the same effect as the first embodiment in saving power when the video signal is not scrambled and the VTR 23 is switched off, with the additional capability to switch two audio channels.

The second, third, fourth, and fifth embodiments can also be provided with additional switches for handling two audio channels. Detailed descriptions will be omitted.

Next, a seventh embodiment will be described. Referring to FIG. 9, the switching apparatus 31 is similar to the switching apparatus in the first embodiment, but has an additional detector 32 that detects the presence of video output from the television set 2. The detector 32 may be a simple circuit with passive components, not requiring a separate power supply. The video output signal TVt(I) from the television set 2 is supplied both to switch SW2 and to the detector 32. The detector 32 generates a detection signal DET that is high when TVt(I) is present, and low when

TVt(I) is absent. The control circuit 30 uses both the information signal DEC(C) and the detection signal DET in controlling the power supplies 11, 12, 13, 14.

Aside from this difference in the switching apparatus 31, the VTR 33 in the seventh embodiment is identical to the VTR in the first embodiment. The television set 2 and decoder 4 are the same as in the first embodiment.

FIG. 10 summarizes the operation of the seventh embodiment, again assuming a tuner setting that selects the TV tuner 5. The state of the detection signal DET is shown for the case in which the VTR 33 is switched off and the information signal DEC(C) is low. The control circuit 30 makes use of the detection signal DET only in this case.

The seventh embodiment operates in the same way as the first embodiment when the main power supply of the VTR 33 is switched on, and when the main power supply of the VTR 33 is switched off if information signal DEC(C) is high.

When the main power supply of the VTR 33 is switched off and the TV tuner 5 is not generating video and audio signals TVt(I) and TVt(A), i.e., when television set 2 is switched off, both the information signal DEC(C) and the detection signal DET are low. In this case, the control circuit 30 turns off all four power supplies 11, 12, 13, 14, inactivating all four switches SW1, SW2, SW3, SW4. No signals are output from the switching apparatus 31 to the television set 2 or decoder 4.

In this state, if the user switches the television set 2 on, the switching apparatus 31 begins to receive video and audio signals TVt(I) and TVt(A) from the TV tuner 5. The detector 32 detects the video signal TVt(I) and the detection signal DET goes high. The control circuit 30 responds by turning on power supply 12 and using control signal C+2 to set switch SW2 to state b, so that the decoder 4 receives the video signal TVt(I) as input signal DECe(I).

If the video signal TVt(I) is not scrambled, the decoder 4 leaves the information signal DEC(C) at the low logic level, and the control circuit 30 leaves power supplies 11, 13, 14 turned off. Switches SW1, SW3, SW4 are inactive; the decoder 4 receives no audio input from the television set 2, and the television set 2 receives no input from the decoder 4.

If the video signal TVt(I) is scrambled, the decoder 4 drives the information signal DEC(C) to the high logic level, and the control circuit 30 activates power supplies 11, 13, 14, so that all four power supplies are turned on. Switches SW1, SW2, SW3, SW4 are all set to state b. The decoder 4 receives scrambled video and audio signals TVt(I) and TVt(A) from the television set 2, and the television set 2 receives decoded video and audio signals DEC(I) and DEC(A) from the decoder 4.

In typical usage, the television set 2 and VTR 33 are both switched off for much of the time every day. In this situation, the seventh embodiment saves even more power than the first embodiment by turning off all four power supplies 11, 12, 13, 14. In other situations, the seventh embodiment provides the same effect as the first embodiment.

In a variation of the seventh embodiment, when the VTR 33 is switched off and the detector 32 detects a video signal TVt(I), if the output of the TV tuner 5 is not scrambled, the control circuit 30 switches power supplies 11, 12, 13 off and power supply 14 on, and the decoder 4 monitors the audio signal TVt(A).

Next, an eighth embodiment will be described. Referring to FIG. 11, the switching apparatus 41 is similar to the switching apparatus in the seventh embodiment, but the detector 42 detects the presence of audio output from the television set 2, instead of detecting video output. The audio output signal TVt(A) from the television set 2 is

supplied to both switch SW4 and detector 42. The detector 42 generates a detection signal DET that is high when TVt(A) is present, and low when TVt(A) is absent. The control circuit 30 uses the detection signal DET in the same way as in the seventh embodiment.

Apart from this difference in the switching apparatus 41, the VTR 43 in the eighth embodiment is identical to the VTR in the seventh embodiment. The television set 2 and decoder 4 are the same as in the first embodiment.

FIG. 12 summarizes the operation of the eighth embodiment, with the same notation and tuner-setting assumption as in FIG. 10. The eighth embodiment operates in the same way as the first embodiment when the main power supply of the VTR 33 is switched on, and when the main power supply of the VTR 33 is switched off if information signal DEC(C) is high.

When the main power supply of the VTR 33 is switched off and the TV tuner 5 is not generating video and audio signals TVt(I) and TVt(A), both the information signal DEC(C) and the detection signal DET are low, and the control circuit 30 switches off all four power supplies 11, 12, 13, 14, inactivating all four switches SW1, SW2, SW3, SW4. No signals are output from the switching apparatus 41 to the television set 2 or decoder 4.

In this state, if the user switches the television set 2 on, the switching apparatus 41 begins to receive video and audio signals TVt(I) and TVt(A) from the TV tuner 5. The detector 42 detects the presence of the audio signal TVt(A) and the detection signal DET goes high. The control circuit 30 responds by switching on power supply 14 and using control signal C+2 to set switch SW4 to state b, so that the decoder 4 receives the audio signal TVt(A) as input signal DECe(A).

If the audio signal TVt(A) is not scrambled, the

decoder 4 leaves the information signal DEC(C) at the low logic level, and the control circuit 30 leaves power supplies 11, 13, 14 switched off. Switches SW1, SW2, SW3, are inactive; the decoder 4 receives no video input from the television set 2, and the television set 2 receives no input from the decoder 4.

If the audio signal TVt(A) is scrambled, the decoder 4 drives the information signal DEC(C) to the high logic level, and the control circuit 30 activates power supplies 11, 12, 13, so that all four power supplies are switched on. Switches SW1, SW2, SW3, SW4 are all set to state b. The decoder 4 receives scrambled video and audio signals TVt(I) and TVt(A) from the television set 2, and the television set 2 receives decoded video and audio signals DEC(I) and DEC(A) from the decoder 4.

The eighth embodiment provides the same power-saving effect as the seventh embodiment.

In a variation of the eighth embodiment, when the VTR 43 is switched off and the detector 43 detects an audio signal TVt(A), if the output of the TV tuner 5 is not scrambled, the control circuit 30 switches power supplies 11, 13, 14 off and power supply 12 on, and the decoder 4 monitors the video signal TVt(I).

The embodiments above have shown how the invented switching apparatus can save power by providing different power supplies for different switches and turning the power supplies on and off individually. For comparison, FIG. 13 shows an audio-visual system with a conventional switching apparatus 101, in which a single power supply 102 supplies power (Vcc) to all four switches SW1, SW2, SW3, SW4. A control circuit 100 switches the single power supply 102 on and off. Control circuit 100 also generates control signals C+1, C+2, and CONT as in the first embodiment. The switching apparatus 101 is disposed in a VTR 103 that is otherwise

similar to the VTR in the first embodiment, and is connected to a television set 2 and decoder 4 as in the first embodiment.

FIG. 14 summarizes the operation of the conventional switching apparatus 101, assuming a tuner setting that selects the TV tuner 5. Under normal conditions the power supply 102 (Vcc) is always switched on. When the VTR 103 is switched on and the information signal DEC(C) is low, the control circuit 100 sets switches SW1 and SW3 to state a and switches SW2 and SW4 to state b, so that the decoder 4 receives the video and audio signals TVt(I) and TVt(A) output by the TV tuner 5, and the television set 2 receives the video and audio signals VTR(I) and VTR(A) output by the signal-processing circuit 7 in the VTR 103. At other times, all four switches SW1, SW2, SW3, SW4 are set to state b, and the television set 2 receives decoded signals DEC(I) and DEC(A) from the decoder 4.

The user may perceive no difference in operation between the conventional system in FIG. 13 and the embodiments of the invention described above, but during the generally long periods of time when the VTR 103 is switched off and the TV tuner 5 is not generating scrambled signals, either because the TV tuner 5 is tuned to an unscrambled channel or because the television set 2 is also switched off, the conventional single power supply 102 continues to consume power by supplying Vcc to all four switches SW1, SW2, SW3, SW4. Over the lifetime of the VTR 103, considerable power is dissipated in this way. The present invention eliminates most of this power dissipation.

A few combinations and variations of the embodiments described above have already been mentioned, but those skilled in the art will recognize that further combinations and variations are possible within the scope of the invention as claimed below.

CLAIMS:

1. A switching apparatus interconnecting a first audio-visual device generating a first video signal and a first audio signal, a second audio-visual device generating a second video signal and a second audio signal, and a third audio-visual device generating a third video signal and a third audio signal, having a first switch operating, when powered, in a first state and a second state, supplying the third audio-visual device with the first video signal in the first state, and with the second video signal in the second state, a second switch operating, when powered, in a first state and a second state, supplying the third audio-visual device with the first audio signal in the first state, and with the second audio signal in the second state, and a third switch operating, when powered, in a first state and a second state, supplying the first audio-visual device with the third video signal and the third audio signal in the first state, and with the second video signal and the second audio signal in the second state, comprising:

a first power supply supplying power to the first switch;

a second power supply supplying power to the second switch;

a third power supply supplying power to the third switch; and

a control circuit coupled to the first power supply, the second power supply, and the third power supply, controlling the first switch, the second switch, and the third switch, and switching the first power supply, the second power supply, and the third power supply individually on and off.

2. The switching apparatus of claim 1, wherein:

the first audio-visual device receives a first external signal, generates the first video signal and the first audio signal from the first external signal, generates a picture from a selectable one of the first video signal and the video signal received from the switching apparatus, and generates sound from a selectable one of the first audio signal and the audio signal received from the switching apparatus;

the second audio-visual device receives a second external signal, and generates the second video signal and the second audio signal from the second external signal;

the third audio-visual device generates an information signal indicating whether the video signal and the audio signal received from the switching apparatus require decoding, and generates the third video signal and the third audio signal by decoding the video signal and the audio signal received from the switching apparatus when decoding is required; and

the control circuit switches the first power supply, the second power supply, and the third power supply on and off individually according to the information signal and an on-off state of the second audio-visual device.

3. The switching apparatus of claim 2, wherein the third audio-visual device outputs the video signal received from the switching apparatus as the third video signal, and the audio signal received from the switching apparatus as the third audio signal, when decoding is not required.

4. The switching apparatus of claim 2 or 3, wherein:

when the second audio-visual device is switched off and the information signal indicates that decoding is not required, the control circuit switches the first power supply on, switches the second power supply and the third

power supply off, and sets the first switch to its first state; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets the first switch, the second switch, and the third switch to their first state.

5. The switching apparatus of claim 2 or 3, wherein:

when the second audio-visual device is switched off and the information signal indicates that decoding is not required, the control circuit switches the second power supply on, switches the first power supply and the third power supply off, and sets the second switch to its first state; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets the first switch, the second switch, and the third switch to their first state.

6. The switching apparatus of claim 2 or 3, wherein:

when the second audio-visual device is switched off and the information signal indicates that decoding is not required, the control circuit switches the first power supply and the second power supply on, switches the third power supply off, and sets the first switch and the second switch to their first state; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets

the first switch, the second switch, and the third switch to their first state.

7. The switching apparatus of any one of claims 2 to 6, wherein:

when the second audio-visual device is switched on and the information signal indicates that decoding is not required, the control circuit switches the first power supply off, and switches the second power supply and the third power supply on; and

when the second audio-visual device is switched on and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on.

8. The switching apparatus of any one of claims 2 to 6, wherein:

when the second audio-visual device is switched on and the information signal indicates that decoding is not required, the control circuit switches the second power supply off, and switches the first power supply and the third power supply on; and

when the second audio-visual device is switched on and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on.

9. The switching apparatus of claim 2 or 3, further comprising a detector detecting presence of a predetermined one of the first video signal and the first audio signal, and sending the control circuit a detection signal reporting detection and non-detection, wherein the control circuit controls the first power supply, the second power supply, and the third power supply according to the detection signal.

as well as to the information signal and the on-off state of the second audio-visual device.

10. The switching apparatus of claim 9, wherein:

when the second audio-visual device is switched off, the information signal indicates that decoding is not required, and the detection signal indicates non-detection, the control circuit switches the first power supply, the second power supply, and the third power supply off;

when the second audio-visual device is switched off, the information signal indicates that decoding is not required, and the detection signal indicates detection, the control circuit switches the first power supply on, switches the second power supply and the third power supply off, and sets the first switch to its first state; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets the first switch, the second switch, and the third switch to their first state.

11. The switching apparatus of claim 9, wherein:

when the second audio-visual device is switched off, the information signal indicates that decoding is not required, and the detection signal indicates non-detection, the control circuit switches the first power supply, the second power supply, and the third power supply off;

when the second audio-visual device is switched off, the information signal indicates that decoding is not required, and the detection signal indicates detection, the control circuit switches the second power supply on, switches the first power supply and the third power supply off, and sets the second switch to supply the first audio

signal to the third audio-visual device; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets the first switch, the second switch, and the third switch to their first state.

12. The switching apparatus of any one of claims 2 to 11, wherein the third audio signal includes multiple audio channels.

13. A method of controlling a switching apparatus having a first switch that, when powered, selectively supplies a video signal from a first audio-visual device or a second audio-visual device to a third audio-visual device, a second switch that, when powered, selectively supplies an audio signal from the first audio-visual device or the second audio-visual device to the third audio-visual device, and a third switch that, when powered, selective supplies audio and video signals from the second audio-visual device or the third audio-visual device to the first audio-visual device, the third audio-visual device detecting whether the video signal received from the first switch and the audio signal received from the second switch are scrambled, decoding the received audio signal and video signal if they are scrambled, providing a decoded audio signal and video signal to the third switch, and generating an information signal indicating the presence or absence of scrambling, comprising the steps of:

supplying power to the first switch, the second switch, and the third switch when the second audio-visual device is switched off and the information signal indicates the presence of scrambling; and

denying power to the third switch when the second audio-visual device is switched off and the information signal indicates the absence of scrambling.

14. The method of claim 13, further comprising the step of denying power to the second switch when the second audio-visual device is switched off and the information signal indicates the absence of scrambling.

15. The method of claim 13, further comprising the step of denying power to the first switch when the second audio-visual device is switched off and the information signal indicates the absence of scrambling.

16. The method of claim 13, 14, or 15, further comprising the step of denying power to the second switch when the second audio-visual device is switched on and the information signal indicates the absence of scrambling.

17. The method of claim 13, 14, or 15, further comprising the step of denying power to the first switch when the second audio-visual device is switched on and the information signal indicates the absence of scrambling.

18. The method of any one of claims 13 to 17, further comprising the step of denying power to the first switch, the second switch, and the third switch when the first audio-visual device and the second audio-visual device are both switched off.

19. A switching device for interconnecting audio-visual devices, the switching device comprising a plurality of switches, wherein at least one of said switches can be turned on or off separately from at least one other of said switches.

20. A switching device for interconnecting audio-visual devices having a plurality of switches, wherein a subgroup of said plurality of switches is powered in a first mode of operation of the audio-visual devices, and all of said switches are powered in a second mode of operation of said audio-visual devices.

21. An audio-visual system comprising audio-visual devices and a switching device as claimed in claim 19 or 20.

22. An audio-visual system substantially as hereinbefore described as any one of Embodiments 1 to 8 with reference to the accompanying drawings.

Amendments to the claims have been filed as follows

1. A switching apparatus interconnecting a first audio-visual device generating a first video signal and a first audio signal, a second audio-visual device generating a second video signal and a second audio signal, and a third audio-visual device generating a third video signal and a third audio signal, having a first switch operating, when powered, in a first state and a second state, supplying the third audio-visual device with the first video signal in the first state, and with the second video signal in the second state, a second switch operating, when powered, in a first state and a second state, supplying the third audio-visual device with the first audio signal in the first state, and with the second audio signal in the second state, and a third switch operating, when powered, in a first state and a second state, supplying the first audio-visual device with the third video signal and the third audio signal in the first state, and with the second video signal and the second audio signal in the second state, comprising:

a first power supply supplying power to the first switch;

a second power supply supplying power to the second switch;

a third power supply supplying power to the third switch; and

a control circuit coupled to the first power supply, the second power supply, and the third power supply, controlling the first switch, the second switch, and the third switch, and switching the first power supply, the second power supply, and the third power supply individually on and off.

2. The switching apparatus of claim 1, wherein:

the first audio-visual device receives a first external signal, generates the first video signal and the first audio signal from the first external signal, generates a picture from a selectable one of the first video signal and the video signal received from the switching apparatus, and generates sound from a selectable one of the first audio signal and the audio signal received from the switching apparatus;

the second audio-visual device receives a second external signal, and generates the second video signal and the second audio signal from the second external signal;

the third audio-visual device generates an information signal indicating whether the video signal and the audio signal received from the switching apparatus require decoding, and generates the third video signal and the third audio signal by decoding the video signal and the audio signal received from the switching apparatus when decoding is required; and

the control circuit switches the first power supply, the second power supply, and the third power supply on and off individually according to the information signal and an on-off state of the second audio-visual device.

3. The switching apparatus of claim 2, wherein the third audio-visual device outputs the video signal received from the switching apparatus as the third video signal, and the audio signal received from the switching apparatus as the third audio signal, when decoding is not required.

4. The switching apparatus of claim 2 or 3, wherein:

when the second audio-visual device is switched off and the information signal indicates that decoding is not required, the control circuit switches the first power supply on, switches the second power supply and the third

power supply off, and sets the first switch to its first state; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets the first switch, the second switch, and the third switch to their first state.

5. The switching apparatus of claim 2 or 3, wherein:

when the second audio-visual device is switched off and the information signal indicates that decoding is not required, the control circuit switches the second power supply on, switches the first power supply and the third power supply off, and sets the second switch to its first state; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets the first switch, the second switch, and the third switch to their first state.

6. The switching apparatus of claim 2 or 3, wherein:

when the second audio-visual device is switched off and the information signal indicates that decoding is not required, the control circuit switches the first power supply and the second power supply on, switches the third power supply off, and sets the first switch and the second switch to their first state; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets

the first switch, the second switch, and the third switch to their first state.

7. The switching apparatus of any one of claims 2 to 6, wherein:

when the second audio-visual device is switched on and the information signal indicates that decoding is not required, the control circuit switches the first power supply off, and switches the second power supply and the third power supply on; and

when the second audio-visual device is switched on and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on.

8. The switching apparatus of any one of claims 2 to 6, wherein:

when the second audio-visual device is switched on and the information signal indicates that decoding is not required, the control circuit switches the second power supply off, and switches the first power supply and the third power supply on; and

when the second audio-visual device is switched on and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on.

9. The switching apparatus of claim 2 or 3, further comprising a detector detecting presence of a predetermined one of the first video signal and the first audio signal, and sending the control circuit a detection signal reporting detection and non-detection, wherein the control circuit controls the first power supply, the second power supply, and the third power supply according to the detection signal,

as well as to the information signal and the on-off state of the second audio-visual device.

10. The switching apparatus of claim 9, wherein:

when the second audio-visual device is switched off, the information signal indicates that decoding is not required, and the detection signal indicates non-detection, the control circuit switches the first power supply, the second power supply, and the third power supply off;

when the second audio-visual device is switched off, the information signal indicates that decoding is not required, and the detection signal indicates detection, the control circuit switches the first power supply on, switches the second power supply and the third power supply off, and sets the first switch to its first state; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets the first switch, the second switch, and the third switch to their first state.

11. The switching apparatus of claim 9, wherein:

when the second audio-visual device is switched off, the information signal indicates that decoding is not required, and the detection signal indicates non-detection, the control circuit switches the first power supply, the second power supply, and the third power supply off;

when the second audio-visual device is switched off, the information signal indicates that decoding is not required, and the detection signal indicates detection, the control circuit switches the second power supply on, switches the first power supply and the third power supply off, and sets the second switch to supply the first audio

signal to the third audio-visual device; and

when the second audio-visual device is switched off and the information signal indicates that decoding is required, the control circuit switches the first power supply, the second power supply, and the third power supply on, and sets the first switch, the second switch, and the third switch to their first state.

12. The switching apparatus of any one of claims 2 to 11, wherein the third audio signal includes multiple audio channels.

13. A method of controlling a switching apparatus having a first switch that, when powered, selectively supplies a video signal from a first audio-visual device or a second audio-visual device to a third audio-visual device, a second switch that, when powered, selectively supplies an audio signal from the first audio-visual device or the second audio-visual device to the third audio-visual device, and a third switch that, when powered, selective supplies audio and video signals from the second audio-visual device or the third audio-visual device to the first audio-visual device, the third audio-visual device detecting whether the video signal received from the first switch and the audio signal received from the second switch are scrambled, decoding the received audio signal and video signal if they are scrambled, providing a decoded audio signal and video signal to the third switch, and generating an information signal indicating the presence or absence of scrambling, comprising the steps of:

supplying power to the first switch, the second switch, and the third switch when the second audio-visual device is switched off and the information signal indicates the presence of scrambling; and

denying power to the third switch when the second audio-visual device is switched off and the information signal indicates the absence of scrambling.

14. The method of claim 13, further comprising the step of denying power to the second switch when the second audio-visual device is switched off and the information signal indicates the absence of scrambling.

15. The method of claim 13, further comprising the step of denying power to the first switch when the second audio-visual device is switched off and the information signal indicates the absence of scrambling.

16. The method of claim 13, 14, or 15, further comprising the step of denying power to the second switch when the second audio-visual device is switched on and the information signal indicates the absence of scrambling.

17. The method of claim 13, 14, or 15, further comprising the step of denying power to the first switch when the second audio-visual device is switched on and the information signal indicates the absence of scrambling.

18. The method of any one of claims 13 to 17, further comprising the step of denying power to the first switch, the second switch, and the third switch when the first audio-visual device and the second audio-visual device are both switched off.

19. A switching device for interconnecting audio-visual devices having a plurality of switches, wherein a subgroup of said plurality of switches is powered in a first mode of operation of the audio-visual devices, and all of said switches are powered in a second mode of operation of said audio-visual devices.

20. An audio-visual system comprising audio-visual devices and a switching device as claimed in claim 19.

21. An audio-visual system substantially as hereinbefore described as any one of Embodiments 1 to 8 with reference to the respective accompanying drawings.

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Examiner: D Midgley
Date of search: 8 June 1999

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H3Q QAFM,QAFX

Int Cl (Ed.6): H04N 5/765,5/775

Other: ONLINE:WPI,EPODOC,JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2199456 A (SAMSUNG) See, for example, page 2, lines 12-24	1,13,20

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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